
Heisenberg spin chain with Sparse Array

```
max = 18;

S[i_] = PauliMatrix[i] / 2;
CircleTimes = KroneckerProduct;

SS =  $\sum_{i=1}^3 S[i] \otimes S[i]$ ;

I[n_] := IdentityMatrix[2^n, SparseArray];

ClearAll[h];

h[L_] := h[L] =  $\frac{1}{L} \sum_{n=0}^{L-2} I[n] \otimes SS \otimes I[L-n-2]$ ;

(Hs = Monitor[Table[h[L], {L, 2, max, 2}] // N,
  {L, max, ProgressIndicator[L, {2, max}]}];) // AbsoluteTiming
{0.3047, Null}

(tb = Monitor[Table[{2 n, Eigenvalues[Hs[[n]], 1] [[1]]}, {n, 1, max/2}],
  {2 n, max, ProgressIndicator[2 n, {2, max}]}];) // AbsoluteTiming
{8.01961, Null}

prediction = Fit[#, x^-Range[0, Length[#]-1], x] &@tb /. x -> ∞
analytical = -Log[2] + 1/4 // N
-0.443146
-0.443147

prediction - analytical
analytical
-3.13279 × 10-6
```

Parallelization

```
$ProcessorCount
4

DistributeDefinitions[Hs];

(Parallelize@Table[{2 n, Eigenvalues[Hs[[n]], 1] [[1]]}, {n, 1, max/2}]) // AbsoluteTiming
{7.41777, {{2, -0.375}, {4, -0.404006}, {6, -0.415596}, {8, -0.421867}, {10, -0.425804},
  {12, -0.428508}, {14, -0.43048}, {16, -0.431984}, {18, -0.433167}}}
```